

Use of Poison Bait to Control Rabies in Tennessee Wildlife

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TENNESSEANS have been concerned with the spread of rabies for many years. From 1931 to 1940, there were more people infected by rabies in Tennessee per capita and per unit of land than in any other State (1). During that period the State had an annual average of 5.5 cases of rabies in human beings. The last recorded human death from this disease was in 1955.

Inoculation programs in the 1950's were highly effective in controlling canine rabies (2) and thereby reducing exposures of persons and cattle to rabid dogs. Since 1956 foxes have had the largest number of laboratory confirmed cases of rabies. Foxes have probably caused large numbers of cattle and increasing numbers of skunks to become rabid.

In 1964 and 1965 there were more cases of rabies in Tennessee wildlife than in any other State. The disease outbreak was actually in two epizootics, in middle and northeastern Tennessee, separated by more than 200 miles.

Beginning in December 1964, the State's news media publicized the spread of rabies in wild-

life. Editorials with such titles as "Rabid animals repel tourists," "State must act faster to curb rabies epidemic," "Bitten, felled, man chokes fox to death," "2nd fox grips farmer's leg, then is killed," and "The war against the mad foxes," led to a type of mass hysteria in some counties.

The Tennessee Legislature was meeting in Nashville in January 1965, and legislators conveyed the feelings of their constituents to the Governor and other leaders of the State government. A statewide bounty of \$3 was proposed but was not passed. Enactment of such a bounty would have been of doubtful value, because the waste and ineffectiveness of bounty programs have been well documented (3, 4).

Officials of interested public agencies from Tennessee and neighboring States met and discussed the difficulty and possible methods of control. Representatives of the Tennessee Department of Public Health felt that control was the responsibility of the Tennessee Game and Fish Commission, because wildlife were being infected by the rabies virus.

The Tennessee Legislature passed bill 51-421 which gave the game and fish commission personnel the right to use any chemical, biological substance, or poison considered necessary by the director to reduce or control any species that might be detrimental to human safety, health, or property (5). The board of health of a county must establish a quarantine on domestic stock and make an official request, through the State commissioner of public health, asking the direc-

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tor of game and fish to take action. The law also specified that the county board of health was to be responsible for publicizing and enforcing the quarantine.

The first efforts to control rabies in wildlife following the increase in cases in 1964-65 were by trapping and hunting. Laboratory examinations for that period showed that 800 foxes, 102 skunks, 45 bats, nine bobcats, 38 house cats, 73 dogs, 166 cattle, and 32 other animals were infected with rabies. The total cost of the epizootic to Tennessee's economy was estimated at more than \$300,000 (6). This estimate includes the value of pets and livestock that died from rabies, the medical expenses for 1,000 persons receiving treatment for rabies exposure, and the value of worktime lost because of the treatment.

Use of Poison Bait

In 1965 strychnine in bait was first used by fish and game commission personnel on Federal lands within the Holston Ordnance Works in Hawkins County. In February and March 1966, Carter and Hickman Counties received State assistance in controlling rabies, the first attempt to control rabies in wildlife by using poison on privately owned land in Tennessee.

Alkaloid tablets containing $\frac{1}{4}$ -grain strychnine were placed within $\frac{3}{4}$ -inch squares of beef suet. Beef chunks, kidneys, which foxes sometimes refused, and cracklings were also tested as bait. Sodium monofluoracetate was tested but seemed to have no advantages over strychnine. Few carcasses of animals that had eaten bait containing strychnine were found, but the poison does not usually become effective for 10 to 30 minutes.

Cases of rabies in wildlife decreased in 1966 when 353 animals, including 192 foxes, were found to be infected on examination in the six State laboratories. Between December 23, 1966, and June 15, 1967, parts or all of 14 counties, in east, middle, and west Tennessee received assistance from the commission in controlling rabies in wildlife.

The absence of rabid foxes in west Tennessee for many years is noteworthy. Only two rabid animals were submitted for examination from west Tennessee between 1946 and 1965. Between November 1966 and May 1967, a total of 13 cases

were reported from Benton, Carroll, and Decatur Counties. Apparently Kentucky Lake normally acts as a buffer zone between western Tennessee and middle Tennessee where fox rabies is enzootic. Occasionally foxes are seen at night on the bridges crossing the lake. Parker reported that the Hudson and Mohawk Rivers act as similar buffer zones in New York State (7).

Distribution of Poison Bait by Teams

Control teams in the 13-county effort were usually composed of two men—a district biologist assisted by either an area aide, a game warden, or a game area manager. The district biologists were the key trained personnel used in all control efforts. These men are assigned to the game management services section of the commission and have either B.S. or M.S. degrees. Control work was supervised by James Hammond, supervisor of the section. All personnel were salaried and their workday normally exceeded 8 hours.

Seventy-one control teams worked in the 13 control counties. Each team worked from 5 to 13 days, treated an average of 58 square miles, and established 131 bait stations or 2.2 bait stations a square mile. Each team was supplied with detailed county maps, rubber gloves, forms on which bait locations and results were to be tabulated, yellow marking tape, marking pencils, strychnine, and beef suet.

A bait route normally covered 60 to 100 miles of roads—a full day's work. Each bait station was listed on a county map and given a number which was placed on yellow flagging tape, and the tape was placed near the bait to assist the team in relocating baits. Baits were checked daily and the results recorded. Bait stations were not established in urban areas or within 100 yards of a residence, but were located along road rights-of-way near known fox habitats.

Effectiveness

In 13 counties 9,301 bait stations were operated for a total of 60,593 bait nights, and 22,847 baits, or 38 percent, were eaten or removed. The animals removing 17,888 baits, or 78 percent, were not identified because tracks could not be seen or tracks of several species of animals were seen. Almost 10 percent of the State, or 4,111

square miles, were treated with poisoned bait (table 1).

Only 22 percent, or 4,959 of the animals accepting bait, could be identified. They were foxes, 43 percent; dogs, 29 percent; cats, 4 percent; birds, 4 percent; other animals, 7 percent; and 13 percent of the baits were removed by human beings. Total bait acceptance for the 11 control units varied from 30 to 47 percent (table 1). Daily bait acceptance varied from 17 to 59 percent (table 2). Acceptance of bait was probably influenced indirectly by the weather because animals tend to move about less during bad weather. As the control efforts continued, it was difficult to find evidence of a decrease in bait acceptance, even when baits were left for 11 days.

From the standpoint of public relations, leaving the baits in place 5 days seemed the most satisfactory. After 5 days, the local people began to pay less attention to the quarantine and as a result more pets were killed. People also stole more baits as they became familiar with the bait locations. Presumably these baits were stolen by persons who (a) wished to protect pets and livestock, (b) generally disagreed with the philosophy of poisoning animals, or (c) wished to use poison in areas and on animals of their own choice.

Few carcasses were found and attempts were seldom made to search for victims. The effectiveness of the program might be questioned because bait acceptance remained high. Bait stations were usually far enough apart (2.2 baits a linear

Table 1. Areas treated with poison bait, nights baits available, and animals accepting bait, Tennessee, December 1966–April 1967

Area treated	Total nights baits available	Bait taken								Bait accepted (percent)
		Foxes	Dogs	Cats	Birds	Man	Other	Unknown	Total	
Henderson-Carroll	2, 212	269	24	2	10	3	1	508	817	37
South Hickman-east Perry	9, 786	349	192	32	35	69	83	3, 259	4, 019	41
West Perry	8, 999	441	195	44	19	60	101	3, 410	4, 270	47
Decatur, Henderson, Carroll, Benton	8, 438	370	171	37	74	196	57	2, 375	3, 280	39
East Hickman	7, 327	162	246	37	16	98	17	1, 617	2, 193	30
Lewis-west Hickman	7, 315	237	251	9	8	50	38	1, 886	2, 479	34
North Wayne	2, 951	112	49	7	15	81	20	881	1, 165	39
Sequatchie-Bledsoe	5, 827	99	145	9	8	61	13	1, 616	1, 951	33
Hamilton	1, 458	36	48	10	2	10	4	393	503	34
Macon	2, 298	11	25	0	0	20	0	911	967	42
Cumberland	3, 982	55	75	2	6	17	16	1, 032	1, 203	30
Total	60, 593	2, 141	1, 421	189	193	665	350	17, 888	22, 847	38

Table 2. Percent of baits accepted each day

Area treated	Percent of baits accepted										
	1	2	3	4	5	6	7	8	9	10	11
South Hickman-east Perry	40	43	37	41	66	48	37	41	---	---	---
West Perry	47	42	43	42	38	42	50	47	48	53	57
Decatur, Benton, Henderson, Carroll	40	40	47	45	36	36	36	38	37	37	43
East Hickman	¹ 59	31	35	30	51	30	26	25	20	17	---
Lewis-west Hickman	35	36	36	59	34	28	30	21	19	---	---
North Wayne	39	42	46	40	39	36	---	---	---	---	---
Sequatchie-Bledsoe	29	33	33	36	33	---	---	---	---	---	---
Hamilton	38	37	31	30	37	---	---	---	---	---	---
Macon	32	43	40	39	38	---	---	---	---	---	---
Cumberland	19	32	29	30	28	---	---	---	---	---	---

¹ 32 bait stations established.

mile) so that it was unlikely that one animal would get more than one bait. If an animal ate several baits, presumably it would vomit the poison and recover. Tracks in the snow indicated that individual foxes seldom traveled more than 300 to 400 yards along a road before leaving it for the adjacent woods or fields; therefore, an individual animal would seldom have an opportunity to pick up two baits. Where baits were closer together biologists did find evidence of an animal vomiting the baits.

Expenditures for the control teams were estimated at \$75 to \$80 a team day, or about \$9 a square mile. These estimated costs included salaries, vehicle maintenance, meals, lodging, poison, baits, travel to and from control counties, and administration. The estimated cost of treating 13 counties was \$36,000. These costs were a substantial improvement over the commission's earlier control costs of \$120 a square mile, using strychnine on privately owned land. The earlier control efforts in Carter County were very expensive because eight district biologists, with high salaries, were used to treat a 20-square-mile valley. The 1965 hunting and trapping program cost \$33.60 a square mile or \$208 a fox killed. A more recent control program of having landowners set out poison bait cost approximately \$1.10 a square mile.

Rabies Control by Landowners

In June 1967 a new type of control was tried. A quarantine went into effect in Sullivan County following radio and news announcements. Two biologists and two county health officials conducted public meetings for three evenings. Landowners, especially farmers, were invited, and rabies in the local foxes was discussed. The use of strychnine in poisoned bait was explained.

Landowners were asked to sign for poisoned baits. Participants were given a postcard addressed to the game and fish commission, which contained a summary form for reporting bait acceptance, number of bait stations established, and the number of animals believed taking bait. The poison was distributed according to the amount of property a person owned, and one strychnine pill was given per 10 acres of property.

Participants signed an agreement that they

would use the chemicals only on their property, in the manner prescribed, for the control of rabies, and only during a specified period. The agreement further stated that the game and fish commission would not assume liability on behalf of the landowner for the use of the chemicals and that the persons putting out the baits would pick up and burn all unused baits on the last day of the quarantine.

Of the 55 persons signing for the baits, 45 returned postcards reporting 484 baits taken from 346 stations. Foxes, opossums, skunks, ground-hogs, dogs, and cats were known to have taken the baits.

Biologists felt that more farmers would have participated if the meetings had been held during the late winter or early spring. Attendance at the June meetings was poor because many farmers were busy planting crops or cutting hay until 9 p.m.

Training landowners to use poison bait was considered successful. Participants were encouraged to locate bait stations near dens or animals trails. One man reported putting out baits for 21 days; however, most reported that they removed the bait after 3 to 10 days. There was only one bait station per 1.2 square mile, although the landowners were fairly well distributed throughout the county. This effort was presumably equal to that of 2.5 control teams and was achieved at a much lower cost.

Advantages to this type of control are many. Bait stations can be located near dens and away from roads and, therefore, fewer pets are poisoned. Baits can be placed adjacent to pasture and farm buildings, where they will eliminate carnivores coming close to livestock and persons. This type of operation is more economical than the other control efforts we tried. Landowners can be instructed how to place poison baits much faster than they could have been taught to set effective traps. If rabies control is necessary in the future, having landowners place baits allows larger areas to be covered early in the year when control is more effective.

Evaluation

The only way of measuring the need to control the spread of rabies is by the number of laboratory confirmed cases reported from a county. Marx (8) felt that in Virginia the num-

ber of laboratory confirmed cases reported by a county during a calendar year is influenced by local interest in rabies control, activities of the local health department personnel, the type of farming in the area, particularly if it is dairying, and the manner local news media publicize the danger of exposure of animals and people to rabies in wildlife.

Data of Verts and Storm (9), based on the examination of animals trapped in Illinois, indicated that reported incidence of rabies is not a reliable index to the true prevalence of the disease. Hayne and Neeley (10) analyzed rabies reports in Tennessee and found a relationship between the number of cattle in a county, the acreage pastured, and the number of rabid foxes reported. A significant relationship seems to exist between the human population of a county and the number of animals reported rabid. These observations lend support to Marx's theories.

At present records of rabid animals examined are the only way of measuring the severity of a rabies outbreak. Counties in Tennessee were ranked by the author according to the number of cases of rabies confirmed by the Tennessee Department of Public Health Laboratories between October 1966 and May 1967. Among those counties with the greatest number of cases, control treatment was applied in six of the top 10. The top three received treatment; however, the next four, Lawrence (24 cases), Maury (24 cases), Smith (19 cases), and Sumner (15 cases), did not. Some of those counties ranking lower might have had more cases if control had not occurred. It also can be argued that efforts to control rabies in wild animals cause more cases to be reported (8) by making the public more alert to abnormally acting animals. Some counties where control might be justified are not being treated. Lack of treatment is due to failure of counties to request assistance and to limited time, money, and manpower for control work. In general areas being treated are those where the disease presents a danger to persons and livestock.

It is difficult to predict accurately where an epizootic might occur. Records show that outbreaks generally occur between December and February. Control efforts carried out before December would precede most outbreaks. County

requests for assistance are not made, however, until several cases indicate an outbreak. Efforts at control are generally carried out during or following the peak of an outbreak when the fox population is already being reduced by disease and when control is less effective.

Control has been beneficial in at least two ways. Some animals representing a possible disease hazard were destroyed and public fears were somewhat relieved. There is no accurate way, however, of measuring the economic or humanitarian benefits of rabies control.

In general we believe that the average citizen welcomed the commission's efforts to control rabies by the use of poison bait. Unfortunately a characteristic of Appalachia and of most of Tennessee is that some rural families keep large numbers of dogs. The owners often do not have their dogs vaccinated, and "Old Blue" is sometimes considered slightly more important than other members of the family. Some dog owners, particularly in rural areas, resented the quarantine and ignored it. A few others claimed they did not hear about the quarantine or plans to use poison bait. Many dogs were killed and some bad publicity resulted. Landowners with weapons threatened several control teams. Other citizens were thankful for the assistance, including the thinning out of the local dog population.

Future efforts of control will explore further the advantages of having landowners distribute poison baits. Poison should be used judiciously, and only in counties where there is a definite need. Further education and immunization programs by the Tennessee Department of Public Health will help control the spread of rabies. The combined efforts of the two State governmental branches will control the hazard of the disease until researchers learn more about the ecology of rabies in wildlife.

Summary

In 1964 and 1965 more cases of rabies in wildlife were reported from Tennessee than from any other State. In 1965, the State legislature authorized the Tennessee Game and Fish Commission to reduce or control any species of animals suspected of having rabies. In 1965 and 1966 bait containing strychnine was distributed on Federal and privately owned lands. In 1966-67 all or parts of 14 counties received control

treatment carried out or directed by commission personnel.

Bait was placed on road rights-of-way with 2.2 bait stations per linear mile. In 13 counties, 9,301 bait stations were operated for a total of 60,593 bait nights and 22,847 baits were eaten or removed. Animals removing 78 percent of the baits were not identified.

In June 1967, landowners, especially farmers, were asked to put out poisoned bait adjacent to pastures and farm buildings, to eliminate carnivores living close by. This system of rabies control is less expensive, requires less professional manpower, and can be started early in the year. The 45 participating farmers reported 484 baits taken from 346 stations.

The first use of poison bait on private land cost \$120 per square mile. Rabies control in the 13 counties cost \$9 per square mile. The 1965 hunting and trapping program cost \$33.60 per square mile. Having individual landowners put out poison bait on their land cost approximately \$1.10 per square mile.

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Recommendations on Poliomyelitis Immunizations

The Public Health Service Advisory Committee on Immunization Practices recommends that poliomyelitis immunization programs for infants and children be actively continued and that special efforts be made to reach segments of the populations with low immunization rates. Immunization of infants should begin at 6 to 12 weeks of age; children and adolescents through high school should be immunized if they have not received vaccine previously. During 1966, a total of 108 cases of poliomyelitis were reported in the United States and Puerto Rico, most of them occurring in southern Texas in unimmunized children less than 5 years old.

Routine poliomyelitis immunization for adults living in the continental United States is not needed at this time because most of them are not likely to be exposed to the disease. Of course, unimmunized adults who come in contact with a person having the disease or who travel to epidemic or endemic areas should be immunized. In addition, persons employed in hospitals, medical laboratories, and sanitation facilities should be considered for the immunization series, especially if there are cases of poliomyelitis in the area.